

Invasive Species Monitoring Objectives (10 March 2004, Draft version 4)

Monitoring

Monitoring is "the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective" (Elzinga et al. 1998). Monitoring is design to detect a change or trend outside the limits of a defined target or threshold value that, in turn, triggers a management action or generates a new line of inquiry. Consequently, a monitoring program's success is dependent on well-articulated objectives that assist in defining a desired condition and how progress toward this condition will be assessed.

Invasive species monitoring can be divided into five broad categories:

- Prevention/early detection,
- Trends monitoring,
- Efficacy of management actions,
- Secondary effects of management actions, and
- Restoration/recovery.

Monitoring Objectives

A comprehensive, long-term monitoring plan for invasive species will include aspects of each of these categories. Such a plan, however, can easily consume a park's, network's, or program's entire monitoring budget if very specific monitoring objectives are not well-defined. A **monitoring objective** as defined by the NPS Inventory and Monitoring Program is a specific statement that provides focus about the purpose or desired outcome of a particular monitoring program. As such, one of the first steps in developing a long-term invasive species monitoring program is to articulate clear monitoring objectives. Together with a well-written justification statement in an acceptable [monitoring protocol](#) (control + click for link), monitoring objectives should define why monitoring is required, what will be monitored or measured, where the monitoring will take place, and when the monitoring will occur (after DeAngelis et al. 2003, p. 168 and Geritzlehner 2003, Module 3).

To be effective, monitoring objectives should be realistic, specific, unambiguous, and measurable. Specific objectives will be based on factors such as input from park managers and scientists regarding important park resources and relevant stressors, ecological understanding and conceptual models, enabling legislation, legal mandates, and planning documents such as the General Management Plan or Resource Management Plan. For the NPS Inventory and Monitoring networks, specific, measurable objectives usually will not be developed until Phase 3 of the planning and design process, though broader objectives are defined in Phase 1. (The I&M networks' inventory and monitoring plans are divided into three phases; Phase 1 includes relatively general monitoring objectives whereas protocol development in Phase 3 necessitates more specific monitoring objectives.)

Monitoring objectives should not be confused with management objectives or sampling objectives. **Management objectives** are realistic, clear, and measurable statements of the

desired future condition of a resource or the desired outcome of a specified management action (e.g., maintain percent cover of less than 5% for all exotic species combined at Manley Woodland from 1999 to 2008). A **sampling objective** complements a management objective by setting specifications for the measurement of the management objective, including confidence and acceptable error boundaries (e.g., to be 90% certain of detecting a 40% change in bird density and we are willing to accept a 10% chance of saying a change took place when it really didn't; see also Elzinga et al. 1998, p. 91). A **monitoring objective** assists in defining the scope of the observations or measurements that will be used to evaluate progress toward the management objective over time. The following are examples of these types of objectives.

Management objective: To reduce by 90% the density of populations of *Centaurea solstitialis* in sites of special concern within GOGA between 2005 and 2009.

Monitoring objective: To evaluate whether the annual treatments of *Centaurea solstitialis* in 10 designated sites of special concern within GOGA reached the target reduction of 90% over a four-year period by monitoring before and after treatment each year.

Sampling objective: To be 95% certain of detecting a 90% change in density of *Centaurea solstitialis* populations in 10 designated sites of special concern within GOGA over a four-year period with a 10% chance of saying a 90% change took place when it did not (a false-change error; after Elzinga et al. 1998, p. 93).

Once formulated, monitoring objectives assist in defining protocol and sampling design needs (i.e., sampling methods, variables to measure, number of replicates, number of plots or transects, plot size and spacing, and frequency and timing of monitoring) and help determine how the information will be used and evaluated after it has been collected.

Examples

The following lists provide examples of generic monitoring objectives and specific, hypothetical monitoring objectives for each of the broad invasive species monitoring categories. Neither set of examples is exhaustive.

Prevention/Early Detection

Generic monitoring objectives:

- To detect incipient populations (i.e., small, and localized) and new introductions of selected invasive species before they become established in areas of management significance over a given period of time.
- To detect invasions via key vectors and pathways for invasive species and their propagules before they become established (e.g. in soil amendments, in "native" seed sources, on construction equipment, on vehicles, via horses, along waterways, etc.)
- To evaluate the relative strength or dominance of vectors or pathways in a given area for a defined period of time with the purpose of focusing monitoring efforts.

- To determine if there are apparent patterns of invasion by specific exotic species or suites of species into specified areas over a certain monitoring period.
- To determine if invasive species are present at points-of-entry to the parks and have the potential for further spread.
- To create and maintain a list of “watch species” which are either known to exist in the region or have the potential to become problematic in the area. A similar list of no- or low-risk species should be maintained with this list. (Although these lists are not monitored per se, they are an integral part of early detection monitoring and will need to be updated frequently based on regional species alerts.)
- To develop and update predictive models of the probability of spread and potential distributions of selected invasive plant species. (Again, the models themselves are not monitored, but they will need to be revised regularly given advances in understanding, technology, and empirical data.)

Specific examples:

- To systematically monitor each public trail in PORE at least once per year for the next 10 years using visual assessment and GPS technology to detect and accurately map incipient populations of the top 10 plant species on the California weed watch list. Monitoring and mapping will be conducted by trained volunteers and interns.
- To evaluate all invasive plant monitoring and mapping data collected along riparian systems, trails, and roads in SAMO every three years to determine the primary pathways leading to new invasions in the park.
- To monitor each of 10 sites of ecological significance in GRTE that are currently weed-free every year for the next 15 years to detect incursions of spotted knapweed.
- To detect biennially the presence of any new exotic plant either on the SHEN watch list of exotic species or deemed by the Commonwealth of Virginia or surrounding states to be highly invasive within specific ecological zones found within the park. Monitoring efforts will be reevaluated every 7-10 years.

Trends Monitoring

Generic monitoring objectives:

- To determine the trends in extent, frequency, abundance, and/or condition of a particular exotic species in a particular area over a specified time period.
- To evaluate the rate of spread of particular invasive species over a set period of time within a defined area.
- To detect changes in native species frequency, abundance, and/or condition in relation to changes in specific invasive species characteristics in a certain area for a given time period.
- To detect changes in native plant community structure and function in relation to changes in specific invasive species characteristics in a certain area for a given time period.
- To detect changes in specific abiotic ecosystem variables in relation to changes in specific invasive species characteristics in a certain area for a given time period.

Specific examples:

- To annually track the percent cover of 12 known populations of *Typha angustifolia* in SLBE over the next 7 years with sufficient accuracy to detect a 20% change between monitoring events.
- To monitor tamarisk in parks across the NCPN every three years over the next 27 years with sufficient accuracy to detect a 30% change in its frequency of occurrence.
- To detect a change outside the natural range of variation in the richness and/or density of documented native forb species in sites occupied by non-native grasses in SAMO. Monitoring will be conducted at least every two years over the next 10 years.
- To determine if non-native plant species richness and cover are increasing in montane meadow communities in SEKI. Selected sites will be monitored annually over the next 10 years for all non-native species.
- To evaluate changes in fire frequency and extent in relation to the continuity and density of *Bromus tectorum*. Monitoring will be conducted every other year in each of the parks in the SCPN by monitoring half of the parks in alternating years over the next 25 years.
- To determine through annual monitoring the distance of penetration of the park's top 10 invasive exotic plants into the high forest from areas of disturbance and development at SHEN.

Efficacy of Management Actions

Generic monitoring objectives:

- To evaluate the effectiveness of management actions used to control, contain, or eradicate specific invasive species to a target level on a given site for a selected monitoring period.
- To evaluate the effects of management actions on native species populations in mixed invasive/native systems in a given area within a specified timeframe.

Specific examples:

- To determine with annual monitoring whether the 2002 *Phragmites australis* spray operation of two sites in ASIS achieved the 90% target reduction in adult stem density and to evaluate the extent of spray damage to native plant species.
- To determine with annual monitoring whether increased mower height along NOCA roadsides is reducing Species X to spot treatment levels and resulting in 90% cover by native species within 5 years.
- To determine whether application of sugar ten days after herbicide application to *B. tectorum* results in 90% cover of native plants within 5 years.
- To annually measure mean foliar damage to *Melaleuca quinquenervia* resulting from bio-control agents (Australian snout beetles). Monitoring will occur in the southwest quadrant of EVER over the next 10 years.

Secondary Effects of Management Actions

Generic monitoring objectives:

- To evaluate the effects of management actions on non-target organisms within acceptable limits in a specified temporal and spatial setting.
- To evaluate the effects of management actions on specified abiotic parameters (e.g., water quality, soil chemistry, air quality) within acceptable limits in a specified temporal and spatial setting.

Specific examples:

- To annually assess the mortality rate of adult, native grasses in 30% of annual post-treatment herbicide applications to leafy spurge infestations in THRO over the next 3 years.
- To detect pesticides used to control invasive species at or above California State standards in all streams in PORE that are within 100 meters of pesticide applications and that support salmonid populations. Monitoring should be conducted one week, six months, and one year after pesticide application.
- To evaluate biennially between 2004 and 2010 the foliar damage to non-target, native emergent aquatic plants caused by stem borers released in SLBE to control *Lythrum salicaria*.
- To evaluate changes in aquatic macroinvertebrate diversity in 30% of selected streams located within 100 meters of all herbicide applications in SHEN. Monitoring will be conducted 1 week before, one week after, 3 months after, and 6 months after application.

Restoration/ Recovery

Generic monitoring objectives:

- To evaluate the response of native plant species and communities to restoration efforts designed to achieve a specified desired future condition in a certain area within a given timeframe.

Specific examples:

- To determine by 2004 whether the control of *Phragmites australis* in CACO conducted in 2002 has led to 90% cover by native species representative of the vegetation prior to *Phragmites* invasion.
- To biennially measure the mean percent cover of native perennial grasses in tallgrass prairie plots in TAPR for 10 years after the initial application of prescribed fire.

References

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- Elzinga, C.L., D. W. Salzer, and J. W. Willoughby. 1998. Measuring and monitoring plant populations. BLM Tech. Reference 1730-1. BLM/RS/ST-98/005+1730.
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